Appendix: Click-based and ptr-operation-based techniques are two approaches to design Chinese input methods on a soft (on-screen) keyboard using pointing devices. In the following we discuss the differences of the two approaches. The use of a mouse is assumed in the discussion. The conclusions can be applied as well to other pointing devices that can generate "press", "release", and "touch" event signals on keys in a software keyboard.

1. Operational differences of click-based and ptr-operation-based key selection techniques.

   Assume that a keyboard is shown on the screen.

   a. Click-based technique: It uses the mouse to click on a key to select that key. A mouse click involves a mouse press and a mouse release operations.

   b. A ptr-operation (press-touch-release): It sequentially uses the mouse to press on a key (key 1), touch a second key (key 2), and release on a third key (key3) to make three selections in one continuous move.

2. Comparison of detailed mouse operation steps to select three keys (key1, key2, and key3)

   a. click-based technique: use the mouse to

      move the curser to key1,
      press mouse button, and
      release mouse button, to select key1,
      move cursor to key2,
      press mouse button, and
      release mouse button, to select key2,
      move cursor to key3,
      press key3, and
      release mouse button, to select key3.

   b. "ptr"-operation based technique: use the mouse to

      move the curser to key1,
      press mouse button to select key1,
      move cursor to key2, to touch and select key2,
      move cursor to key 3,
      release mouse button to select key3.

   The comparison above shows that ptr-operation is much more efficient. Furthermore, to touch a key to select is easier than to click the key to select because to touch a key the mouse cursor need only pass the key top, while to click a key, the mouse cursor need be moved to right onto the key top.

3. Comparison in the case of entering full phonetic spelling of a Chinese character.

   Example. The full spelling ㄐㄧㄢˇ of the Chinese character 剪 is to be entered into a computer, where ˇ represents the third tone in a Chinese character pronunciation.

   a. click-based technique: use the mouse to

      move the curser to ㄐ,
      press mouse button, and
      release mouse button, to select ㄐ,
      move cursor to ㄧ,
      press mouse button, and
      release mouse button, to select ㄧ,
      move cursor to ㄢ,
      press mouse button, and
      release mouse button, to select ㄢ,
      move cursor to ˇ,
      press mouse button, and
      release mouse button, to select ˇ.

   b. ptr-operation based technique: A user has the option to touch and select a tone key at the end of the ptr-operation. He uses the mouse to

      move the curser to ㄐ,
      press mouse button to select ㄐ,
      move cursor to ㄧ to touch and select ㄧ,
      move cursor to ㄢ,
      release mouse button to select ㄢ,
      move cursor to ˇ to touch and select ˇ.

4. Comparison in the case of entering partial leading phonetic strings of Chinese characters.

   Example. Entering the partial leading strings ㄐㄧ of ㄐㄧㄢˇ of the Chinese character 剪.

   a. click-based technique: use the mouse to

move the curser to ㄐ,
press mouse button, and
release mouse button, to select ㄐ,
move cursor to ㄧ,
press mouse button, and
release mouse button, to select ㄧ,
move cursor to the key for the separation mark,
press mouse button, and
release mouse button, to select separation mark.

b. ptr-operation-based technique: use the mouse to

move the curser onto ㄐ,
press mouse button to select ㄐ,
move cursor onto ㄧ,
release mouse button to select ㄧ.

Because a ptr-operation clearly indicates the end of the partial leading string to be entered with the press of the mouse button for the next syllable, a separation mark key is not needed in its operation. That is, ptr-operations include the separation automatically, while extra separation marks are needed to separate phonetic syllables using traditional mouse clicks when a parsing ambiguity situation arises. This is especially true, and much more often, for entering partial phonetic spellings.

5. Comparison of the use of separation marks in a sequence of partial spellings.

Example. To enter the leading string (ㄒㄧ)(ㄢ) for the phrase 西(ㄒㄧ)安(ㄢ).

a. Click-based technique: needs to insert a separation mark between ㄒㄧ and ㄢ to indicate that the sequence is not the sequence of leading phonetic strings of 賢 (ㄒㄧㄢ) or the leading phonetic strings of 斜(ㄒㄧㄝ)陽(ㄧㄤ)暗(ㄢ).

b. ptr-operation-based technique: The press of mouse button in the "ptr"-operation clearly indicates the end of the previous phonetic string. Therefore, it is unnecessary to use separation marks. A user can seamlessly enter a sequence of partial spellings by a corresponding sequence of ptr-operations.

6. Comparison of refining phrase candidate set by full spellings versus by partial leading phonetic strings.

   "Zhang" uses the full spellings of the first and the second characters (column 3, line 15-19) of the phrase to specify phrase candidate set. "Zhang" included a syllable dividing mark in his on-screen keyboards but didn't describe how to use it. "Zhang" didn't address the issue of possible parsing ambiguity problem either.

   Entering full spellings for phrase selection is called the standard method in early Chinese input system such as TwinBridge. An abbreviated method has also been used in TwinBridge, where a user is allowed to enter only partial spellings to specify phrase candidate set.

   In general, specifying partial spellings is a far more powerful strategy than sticking to finishing the full phonetic spellings of each character for phrases of length greater than two.

   For example, after ㄐ and ㄩ are entered as the first two symbols for the first character of a phrase, it can only be followed by ㄝ,ㄢ,ㄣ, and ㄥ. At this instant, if the input procedure jumps to the next character instead of sticking to finishing the full spelling of the first character, there are more than 26 possible choices for the initial phonetic symbol (i.e., ㄅ to ㄙ,ㄧ,ㄨ,ㄩ,ㄞ,ㄠ,ㄡ,ㄦ) of the second character. This shows that the strategy of specifying a sequence of partial spelling has a much stronger phrase set refining power than sticking to finishing the full spelling of each character.

7. Comparison of keyboard layout and mouse operations.

   The consonants (ㄅ to ㄙ), transition vowels (ㄧㄨㄩ), vowels (ㄚ to ㄦ), and tones (tone 0 to tone 4) are grouped and placed into separated sections on the screen to facilitate key selection operations in many soft keyboard design. This grouping of keys has been done in the standard Zhu-yin keyboard layout (for example, in TwinBridge, Users Manual version 4.0), in "Zhang", and in our invention. However, in order for a keyboard layout to take full advantage of ptr-operations, the following arrangements of the sections are required, or at least highly desirable.

   a. The consonants, transition vowels, and vowels sections are to be placed into neighboring areas.
   b. The transition vowels are arranged into an array in such a way that the dimension of the array is perpendicular to the direction from the consonants section to the transition vowel section. For example, if the consonants section is placed to the left of the transition vowels section, then it is better to arrange the transition vowels into a vertical array to allow easier touch operation and to avoid generating spurious touch signals when the cursor is moved from a consonant to a transition vowel.

c. It is better to arrange the sections so that the trace of the move of the mouse is closer to a straight line. A cursor trace with a large curvature may be acceptable in click-based design such as in "Zhang" but is not suitable for ptr-operation. This is because that when one moves the cursor in a curve it hard to hit the second and the third keys.
d. Although the tone keys are used less frequently in the ptr-operation based input method. They are still better to be arranged into an array to allow easier touch operations.

If the ptr-operation has not been considered as a priori in the design of a soft keyboard layout, the resulting keyboard may become unsuitable to perform ptr-operations. The on-screen Chinese keyboards in "Zhang" (Fig. 2-9, 16-19) are these cases where the transition vowels are arranged into horizontal arrays and it makes the transition vowels hard to touch when the cursor is coming from a key in the consonant section. "Zhang" further arranges the phonetic sections into a partial circle to facilitate a clockwise cursor move. This circular arrangement is certainly not suitable for, and is really a hindrance to, the cursor move to perform ptr-operations.

Conclusions

Based on the above discussions we can draw the following conclusions:

1. ptr-operation is a innovative and easy to apply technique to sequentially select three keys on the screen.
2. ptr-operations can be used to select partial and full spellings of Chinese characters.
3. A ptr-operation is much more efficient than a click-based operation in entering phonetic symbols for Chinese characters.
4. A sequence of ptr-operations can seamlessly generate a sequence of partial spellings of Chinese phrases without using separation marks.
5. Without considering the ptr-operation as a priori in the keyboard design, the resulting keyboard may actually become unsuitable to perform "ptr"-operations.

We believe the above points support our assertion that our keyboard layout and associated ptr-operations are true innovations, and certainly not trivial enhancements to Zhang's approach.